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ABSTRACT

Presented is an executive summary of a study to collect information needed by policymakers and educators about the status of science education in two-year colleges. Data were collected from college administrators, faculty, and students by means of questionnaires. A sample of colleges was selected from a directory of all public and nonproprietary private two-year colleges. One hundred and eighty-three institutions agreed to participate. Faculty and student samples were selected randomly from lists of course sections in each field. Findings and recommendations are summarized in the final chapter which presents an overview of the characteristics of two-year colleges and information obtained from various types of institutions. Other findings related to institutions, faculty, and students are listed by the appropriate category. (Author)

A COMPREHENSIVE ASSESSMENT OF SCIENCE EDUCATION IN THE TWO-YEAR COLLEGE

Executive Summary

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1. BACKGROUND AND OBJECTIVES OF THE STUDY

Background

Two-year colleges have become major sources of science education in this country. Approximately 1,300 of these colleges currently enroll more than four million students -- one-third of the total undergraduate population, and approximately two-thirds of the freshmen in all institutions of higher education.[1] Many two-year college students are enrolled in traditional transfer programs leading ultimately to baccalaureate degrees. Most of these students take degree-credit science courses, and many eventually may earn science-related B.S. or B.A. degrees.

An increasingly large proportion of two-year college students is enrolled in occupational and technical programs. According to data from the American Association of Community and Junior Colleges (AACJC), 50 percent of all two-year college students were enrolled in such programs in 1976, compared to only 13 percent in 1965.[2] A fairly large number of these students are in science- and engineering-related programs. Traditional science courses, as well as science-related community service programs and interdisciplinary studies, also have attracted noncredit students, whose numbers have expanded rapidly in recent years.[3]

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[1] Andrew Hill, Science Education in Two-Year Colleges: Psychology (Los Angeles: Center for the Study of Community Colleges, and ERIC Clearinghouse for Junior Colleges, 1980), p. 1.

[2] American Association of Community and Junior Colleges, Fact Sheets on Two-Year Colleges (Washington, D.C.: AACJC, 1976).

[3] Florence B. Brawer and Jack Friedlander, Science and Social Science in the Two-Year College (Los Angeles: Center for the Study of Community Colleges, and ERIC Clearinghouse for Junior Colleges, 1979), pp. 1-2.

Despite the important role of two-year colleges in science education, little is known about the adequacy and needs of science programs in these colleges. Currently available national statistics on these institutions are too general to draw specific conclusions about science programs. Most estimates of the proportions of students enrolled in science programs or classes are out-of-date, and more importantly, such estimates tell nothing about the characteristics of science students (their ages, educational goals, perceptions of the effectiveness of their education) in the wide variety of science and technology programs offered by two-year colleges.

Similarly, little information exists about science faculty and about the resources available for science education in two-year colleges. When the two-year college movement began its rapid growth in the 1950s and 1960s, faculty members were recruited from the ranks of high school teachers. A widespread impression exists that the senior faculty members are these former high school teachers. Faculty positions later were filled from another group of people, frequently young men and women with newly obtained master's degrees, although quite a number had Ph.D.'s. It is fair to ask how well prepared many faculty members are to teach academic science in their fields, especially since their teaching and advising responsibilities significantly differ from those of four-year college faculty members.

This paucity of information sources about science education in two-year colleges has been a matter of concern to policymakers. In order to fill this gap, Congress directed the National Science Foundation, in the Foundation's Authorization Act for Fiscal Year 1978, to conduct a national needs assessment of science education in two-year colleges.[4] In explanation of this requirement, it was stated that

[4]National Science Foundation Authorization Act, FY 1978, Public Law 95-99.

"The comprehensive assessment of science education in two-year colleges will provide the basis for an understanding of the unique role of those colleges in science education and the problems they face. The results are to be used to assess the effectiveness of current science education programs and to make those programs more relevant to the needs of two-year colleges.

. . . . .

"In the national needs assessment one or more grants should be awarded for comprehensive national surveys on selected topics designed to yield an understanding of the needs of two-year colleges in science education. Relevant questions may include types and needs of students, types of programs, needs and character of faculty, and measures of programs effectiveness."[5]

Objectives

This study was conducted, therefore, to collect information needed by policymakers and educators to better understand the status of science education in two-year colleges. Its primary purpose was to identify the role of two-year colleges in science education and the extent to which they fill that role. The results of the study can provide a basis for understanding the functions, programs, and teaching methods of science education in these colleges.

Based on data collected from the samples of two-year college administrators, faculty, and students, the study examined the following issues:

- INSTITUTIONAL support of science education in two-year colleges;

[5]Conference Report 95-504, 95th Congress, First Session, July 20, 1977, pp. 15-16.

- Social science, natural science, mathematics, engineering, and technology STUDENTS in two-year colleges; and
- Social science, natural science, mathematics, engineering, and technology FACULTY in two-year colleges.

Study procedures, major findings, and recommendations are summarized in the following two sections of this report. For a more in-depth explanation of methodology, findings, and recommendations, as well as detailed data tabulations, the reader is referred to Volume 1 (Technical Report) and Volume 2 (Appendices).

2. STUDY METHODOLOGY

To assess the needs of two-year colleges in science education, a survey of colleges was conducted to obtain information from three sources:

- A sample of two-year colleges, with institutional data supplied by an official appointed by each college;
- A sample of faculty members selected from the college sample; and
- A sample of students, selected from a designated class section of each instructor in the faculty sample.

College Sample

The sample of colleges was drawn from all public and nonproprietary private two-year colleges stratified by the following characteristics:

- Type of control (public vs. private);
- Type of institution (comprehensive vs. technical); and
- Size of student population (number of full- and part-time students enrolled in credit courses).

The unit for the college sample was the individual college campus -- a single, educationally self-sufficient campus with its own buildings, administration, and faculty. The questions asked in this survey about facilities and program offerings could have been answered only with respect to a specific campus and not to a college system as a whole.

The source used to select the sample was the 1979 edition of the Directory of Community, Junior, and Technical Colleges, published by the American Association of Community and Junior Colleges (AACJC). The 1979 edition contained information on 1,245 colleges, including student enrollment current as of the fall semester, 1978.

Responses from a sample of 200 colleges were desired for the study, so the initial sample contained 240 colleges. Each of these 240 schools was invited to participate in the survey. By the cutoff date, 183 had agreed to do so. During the final data collection, usable replies were received from 168 colleges.

Faculty and Student Samples

To draw the faculty and students samples, class sections were selected by first listing all course sections within a curriculum field for all colleges and then selecting randomly the appropriate number of course sections in that field.

Class sections were chosen in five broad curriculum areas (life sciences, physical sciences, engineering and technology, mathematics and computer sciences, and social sciences). The teachers of these class sections became the faculty sample (arrangements were made to avoid choosing the same instructor twice), and students in these classes formed the pool from which the student sample was drawn. This method provided a sampling of faculty and students across colleges for each of the broad curriculum areas. Adjustments were made so that each college had no fewer than two class sections in the sample and no more than ten across all five curriculum fields.

Each faculty member in the sample was asked to give student questionnaires to four students in the selected class. These students were chosen randomly from within the class. To compensate for varying class sizes, a table was provided presenting the method of student selection based on the number of students in the class.

Instrumentation

Data were collected by three questionnaires. The institutional questionnaire was designed to be completed by a representative of the college who had an overview of its educational program in the science and technology areas. This questionnaire primarily tapped information on educational fields that need improvement and on the types of improvement required. The faculty questionnaire was general enough to be meaningful to faculty in all the scientific disciplines, mathematics, technologies, and social sciences, focusing on those elements that are of particular importance to the sciences and on areas in need of improvement. The student questionnaire was intended for any student (science major or nonmajor) enrolled in any course within the defined areas of science and technology. The questionnaire included items on student background characteristics, as well as on needs for improvement in science education, as perceived by students.

Survey Procedures

Data were collected during the spring session of 1979, between April 15 and May 31. Each of the 183 participating colleges sent its course catalogue, schedule of spring classes, and the name of a college official who would coordinate the survey

on the campus and also answer questions about the institution. Complete sets of questionnaires for institutions, faculty, and students were sent to survey coordinators at these 183 colleges. Usable replies were received from 168 colleges, a response rate of 90.8 percent. Of the 974 faculty members to whom questionnaires were sent, replies were received from 831 (85.3 percent). Student questionnaires were distributed to 3,896 students, with 3,238 (83.1 percent) returning usable data.

In addition to data on the status and needs of science education, as perceived by college administrators, faculty members, and students, data on faculty members' and students' background characteristics also were collected. The returned questionnaires were processed, and three separate data files were created for analysis.

Data Presentation and Analysis

All statistics were weighted to provide unbiased estimates of population values. Each college in the sample was weighted by a factor determined by the category of college it was intended to represent. The numbers of colleges by type, therefore, totals 1,232.

For ease in presentation, colleges were grouped into five categories reflecting a combination of institution type and size. These categories are:

- Technical institutes;
- Private colleges (nontechnical);
- Public comprehensive, small (up to 1,499 students);

- Public comprehensive, medium (1,500 - 7,499 students); and
- Public comprehensive, large (over 7,500 students).

Analyses involving faculty and student questionnaires are shown both by type of college and by educational field. The original five fields listed above were further refined to allow for a finer breakout of the life sciences, mathematics, and computer sciences. Eight fields of study are reported separately, as follows:

- Introductory biology
- Health sciences
- Other life sciences (advanced biology and agriculture)
- Physical sciences
- Engineering and technology
- Mathematics
- Computer sciences
- Social sciences

3. FINDINGS AND RECOMMENDATIONS

This study has provided a considerable amount of information about the status and needs of science education in two-year colleges. While each of the three questionnaires focused on issues unique to each group (administrators, faculty, and students) they also elicited information on certain common concerns, such as equipment and facilities improvement, faculty development, and student needs. Except in a few cases, such as the appropriate composition of faculty (full- versus part-time) and the evaluation of teaching methods, perceptions of needs in science education from all three data sources appear to be highly consistent. This consistency in turn adds credibility to the data provided by the three sources.

Overview of Two-Year College Characteristics

The extent of need for improvement in science education varies by type of institution, just as characteristics of two-year colleges vary. Throughout this study the data have shown that marked differences exist among the five types of colleges. In general, medium comprehensive schools are perceived as more closely meeting the needs of students and faculty than other types of colleges. Next most favorably rated are the large comprehensive schools. At the lower end of the scale are private colleges, technical institutes, and small comprehensive schools. Selected characteristics that serve to distinguish each type of college from the others are summarized below.

Medium Comprehensive Colleges

Medium comprehensive schools (those enrolling between 1,500 and 7,500 students) received the most favorable responses of all college types on items measuring science education quality and needs. Fewer medium comprehensive colleges indicated need for computer equipment or equipment installation. Administrators of medium comprehensive schools assigned higher ratings to their colleges' instructional media (book collections, journals and periodicals, reference volumes, and audiovisual materials) than did administrators in other colleges.

Students in medium comprehensive schools generally are pleased with the quality of instruction they receive. They are more satisfied than students in other colleges that their science courses meet their educational needs, and more of them would recommend their courses to friends.

Proportionally more men and fewer women teach in medium comprehensive colleges than in other types of schools. Full-time faculty in these colleges carry slightly heavier teaching loads, with an average of 12.2 credit hours. Medium comprehensive colleges constitute about one-third of all two-year colleges. As a group, they enroll more students and employ more faculty members than any other single type of college; more than a third of all two-year college faculty (full- and part-time) teaches in medium comprehensive schools.

Large Comprehensive Colleges

On most variables, large comprehensive colleges rank the same or slightly below medium comprehensive schools. However, on a few items, large comprehensive colleges were ranked the

highest. When it came to reporting positive measures to encourage the enrollment of women, racial/ethnic minority students, and handicapped students, these schools ranked higher than all the others. Fewer large comprehensive college administrators indicated need for improvement in science education facilities than did administrators in other schools, and almost none reported a need for laboratory equipment.

Large comprehensive colleges have the highest percentage of faculty with doctorates, although relatively fewer of their faculty members have participated in NSF programs. Large comprehensive colleges employ more part-time faculty than do other college types, and a higher percentage of class sections are taught by part-time faculty members.

More men than women students attend large comprehensive schools; 44 percent of their students are part-time. Most of the Asian and Hispanic students are enrolled in large comprehensive colleges. The median age of students is nearly 23 years -- higher than for other college types.

Small Comprehensive Colleges

Small comprehensive colleges definitely differ from the two larger types. They offer very little, compared to other comprehensive schools, in science-related career programs. Fifty-five percent of the small comprehensive college students are in social science courses, compared to 45 percent for all colleges combined. These students are relatively unhappy with the science facilities and laboratory equipment in their schools.

The proportion of part-time faculty in small comprehensive colleges is quite small. More of these faculty than in any

other type of college have attended NSF programs, but they report less recent involvement in self-improvement activities than faculty in other schools. Their current need for substantial preparation in courses that they are now teaching is higher than for other groups.

Administrators acknowledge the past participation of small comprehensive college faculty in NSF programs by rating faculty as having a low need for teaching improvement. These administrators are not satisfied with their libraries or their audiovisual materials. Small comprehensive colleges currently have no students majoring in computer sciences. Administrators of these schools perceive a need for improvement in computer science programs, and they registered strong need for computer equipment as well. Small comprehensive schools rank lower than other college types on measures to encourage women, minorities, and the handicapped in science education.

Private Colleges

Private colleges are in great need of facilities and equipment for the basic sciences. They have a greater need than other college types for major construction. Their libraries and audiovisual resources are rated low. A large proportion of private colleges does not offer physical facilities to help handicapped students, nor have they done much to encourage their enrollment.

Very few private college students are enrolled in the technologies, and none is in computer sciences. Private colleges do enroll a greater than average proportion of students in the health sciences, introductory biology, and other life sciences. This enrollment pattern probably is related to the fact that 72

percent of their students are women. Ninety-two percent of their students attend full-time, and they tend to be a little older than the average. The proportion of black students taking science courses is by far the greatest at private colleges. Students tend to choose private colleges because of their reputations. However, private college students are less satisfied than other students with all kinds of facilities and are particularly critical of laboratory space and equipment. They are not happy with libraries and audiovisual materials either. Class size is a cause of dissatisfaction, and on this point, the private college faculty agrees

Private college faculty members also agree that laboratory facilities and equipment are not satisfactory, and they are critical of the lack of clerical help. These faculty members generally give their colleges low ratings on many items, but they are very positive about the teaching environment. An unusual aspect of faculty composition at private colleges is the large proportion of part-time faculty who are also college administrators. This phenomenon is not evident in other types of colleges.

Technical Institutes

Technical institutes show great need for improvement of existing programs and for additional programs, mostly in the technologies and in physical science. Facilities and equipment needs are high, but faculty development is also necessary. A large proportion of the faculty is viewed as needing improved knowledge of content and, especially, more work experience. Nevertheless, the faculty is given credit for a good deal of recent effort at self-improvement.

Proportionally few faculty members in technical institutes have participated in NSF programs; a low percentage holds

doctorate degrees. One-third of the faculty possesses only bachelor degrees, or less. A high proportion of the faculty is female. Faculty members agree that laboratory facilities and equipment are not as good as they should be, and they also complain about a lack of clerical help.

Students at technical institutes share faculty and administrator perceptions of the need for better facilities and equipment. On the average, they are the youngest group of students; 82 percent of them attend full-time. They chose technical institutes both for convenience of location and for college reputation. Over half of these students are men. Twenty-one percent plan to seek employment after earning their associate degrees, the highest proportion for any type of college. Nevertheless, over half of the technical institute students intend to obtain bachelor or graduate degrees. They are, as might be expected, more concentrated in engineering and technology and other career programs than students in other colleges.

Other Findings

Other major findings, for institutions, faculty, and students, are listed below. Again, the reader is referred to Volume 1 (Technical Report) for discussion of these findings and of the recommendations that follow them.

Institutions

- Most science fields, particularly computer science, are perceived to be in critical need of improvement.
- Overall, improvements in equipment, facilities, and faculty development are indicated most frequently, but the priorities vary by educational fields and types of colleges.

- Needs for computer equipment and for better libraries are expressed strongly by all respondents. Over one-third of all college administrators indicated a need for computer equipment or installation.

- There is no significant indication of need for revising course content or curriculum structure for existing science programs in two-year colleges.

Faculty

- A substantial proportion of faculty members expresses the need for upgrading their knowledge of content and teaching methods.

- Faculty members in general like their teaching environments, but they express need for better support services.

- Full-time faculty in two-year colleges have heavy teaching loads and spend little time in other professional activities.

- Part-time faculty members, who constitute about 30 percent of all faculty, carry a substantial teaching load in two-year college science education -- about 16 percent of the total credit hours in all fields combined.

- About 80 percent of science faculty members hold advanced degrees; 62 percent have master's degrees, and 18 percent possess doctorates.

- The projected supply and demand for two-year college science teaching manpower needs further examination, especially since there is no longer a great demand for faculty drawn from the high school teacher population.

Students

- A substantial proportion of science students in two-year colleges lacks adequate language, study, and math skills.

- Students in science education generally are satisfied with their courses and programs.

- Science education programs in two-year colleges provide a substantial number of students with an opportunity to change their careers.
- Students enrolled in technical institutes and in career-related programs have difficulty continuing their education in four-year institutions.
- There are as many women as men in two-year college science education programs, but women still concentrate in the social sciences and life sciences, while men are in the physical sciences and engineering and technology.
- Differences in science education enrollment patterns exist among racial and ethnic groups, but reasons for these differences are not clear.

Recommendations

Based on the study findings summarized above, six major recommendations are made to improve science education in two-year colleges:

1. A program should be developed, utilizing Federal and state resources, to provide assistance to institutions in accordance with their own priorities for program, facility, and equipment improvement.
2. An expansion of NSF educational development programs is needed in order to provide greater opportunities for faculty members to improve their subject matter knowledge and teaching methods and to gain work experience.
3. Teaching manpower in science education should be examined in light of supply and demand, and preventive measures should be taken to avoid a shortage of qualified faculty.
4. Colleges should expand remedial programs to improve students' language, mathematics, and study skills and should provide improved counseling programs for students who are switching careers or reentering the labor market.

5. Consideration should be given to conducting further research to examine why relatively large proportions of women and some minority group members enroll in certain science fields.

6. The problem of articulation with four-year colleges for transfer students in career programs should be examined further and resolved.